Bridge Construction Inspection

Schedule

Overview of Course

Part 1

Types and Functions of Structures

Minor Structures

Headwalls - drainage
Box culverts
Retaining walls
Barrier
Manholes
Catch basins

Major Structures / Bridges

Span Rivers - Streams - Canyons
Span Highways
Elevated Roadways
Span Lakes, Bays, or Inlets

Substructure

Foundation - Native Soils, Piling, and Drilled Shafts support the structure and footings
Footings - support the structure
Columns - placed on footings for height
Crossbeams - placed on columns / support girders
Abutments - contain fill / support the ends of the structure / allow movement

End / Wing walls - Contain fill material and extend away from the structure
Curtain walls –Hide the bearing areas and extend toward the structure

Superstructure

The Bearings – Support the structure and provide for expansion and contraction of the bridge.
Girders – Deep beams **s**upport the roadway **(Various Types)**
Diaphragms – Provide lateral support between girders
Deck - Supports vehicles / allows for a smooth ride
Barrier - Provides safety for vehicles to prevent driving off the structure

Types of Bridges

Pre-Cast Concrete

Girders stressed prior to and/or after erection
Concrete box girder tubs – post and/or pre-stressed
Prestressing for some segments is to allow for stresses during shipping, they are then post tensioned to allow for the loads imposed by dead weight and traffic loads.

Cast in Place

Concrete box girder / Segmental / Cable stay
Concrete Arch / T – Beam / Flat slab

Steel

Steel plate girder – concrete deck
Steel box girder – concrete deck
Steel truss – concrete deck

Part 2

Preconstruction Preparations

Contract Documents

Standard Specifications - Provide general Information and requirements for all projects
Amendments - Provide revisions to spec's
Standard Plans - Most used drawings
Contract Plans - Details for specific project
Special Provisions - Unique specification requirements
Addendum's - Changes during the ad period

All concrete construction is governed by the previous documents
Inspector should be thoroughly familiar with all contract documents
Review them thoroughly before the project
Refer to them often throughout construction

Hierarchy - 1-04.2

Contractor Submittals

Work schedule - signs, erosion, order
Equipment for shafts
Subcontractor approvals
Temporary water pollution / erosion control
Materials submittals and mix designs
Shop drawings - Shoring and cribbing, cofferdams, forms and falsework, prefabrication, and post tensioning, check the weather-cold weather plan

Plans and Familiarization

Plans and Special Provisions
Material, Elevations, and Dimensions

Specifications -
Highlight and add notes to plan sheets

Permits -
Check for special needs, add to plans

Contractor Provided Documents -
Field conditions, elevations, dimensions and anything - Approved as Noted

List discrepancies and report to supervisor
Traffic control, materials, shop drawings etc..

Check ROM and write pay notes if possible
Excavation, neat line concrete for footing etc..

Attend preconstruction conference
Get start date and schedules, stake class A signs, sub contractor documentation, drainage, erosion/pollution, and material documentation

Staking for Structures

The agency is responsible for the basic staking of alignment and grade control. Get an independent check of staking and review the construction manual, section 1-5

The contractor is responsible for preserving stakes and monuments, setting own string lines and batter boards etc… and providing stakes for inspection purposes

Alignment and Grade Control

Set top deck elevations at ten feet, on webs, with camber and no crush. The contractor sets screed rails from elevations we provide, WSDOT checks. Check the drum elevation from a single known point. Check all deck forms, expansion jts, Drainage and bulk heads from drum. Do not change the drum settings once established, only change the forms, if necessary.

Superstructure - Box Girders

Profile bridge deck at barrier location

Locate low spot in profile. Set barrier top of curb grade a maximum of 3" above the low spot. Contractor sets anchor bolts for rail, signs, and light standards. WSDOT establishes the location and elevation for all anchor bolts and bearings. All surveying needs checked independently.

Part 3

Basic Concrete

Pre-pour Activities

Minor Structures
Reinforcement
Forms and Falsework

Standard Plan Retaining Wall

Use the Field Note Record in this manual and complete a typical pay note for a 10 foot retaining wall.
How many "E" bars will be required?
How many "Q" bars will be required?
How much concrete is required?

Checking quantities with the Standard Plan D-1a

Review the field note with the standard plan and check your quantities.

For changes, always check the factors

Designer for each item involved
Field engineer for effectiveness
PE for cost approvals
Grades / profiles
Dimensions

Reinforcing Steel

The contractor is responsible for determining & ordering quantities.
Column steel should not be ordered before foundations are excavated

Reinforcing steel delivery

Epoxy bar must be protected and handled properly
Check for manufacturer of (Foreign or Domestic) material and rust.
Check bar mark #'s, proper length, and bends

Reinforcing steel placement

Spacing
Size
Clearances
Splice locations
Check the layout before steel is placed - Endo is a term used to stop or start the layout of a specific bar

Wire ties

To firmly hold steel in place
Tie all intersections if bar spacing is 1’ or more, or if epoxy bar is used
Tie alternate intersections if spacing is less than 1’ except epoxy bars
No welding of any kind without written approval
Bend stirrups 135^0 over top matt to prevent floating
For barrier, bend ties away from the face to prevent rust stains

Reinforcing steel splices

Lap splice, only at locations shown, must have full contact tied at both ends
Welded Splice, approved weld procedure and welder for each type of weld
Mechanical couplers, must be approved and tested

Rebar supports must

Be of the approved type
Provide specific clearance
Be placed to prevent displacement
Be replaced if damaged

Typical support types

Reinforcing Steel **(Mortar blocks)** do not stack between mats
Reinforcing Steel **(Chairs)**
Epoxy Coated Reinforcing Steel Supports

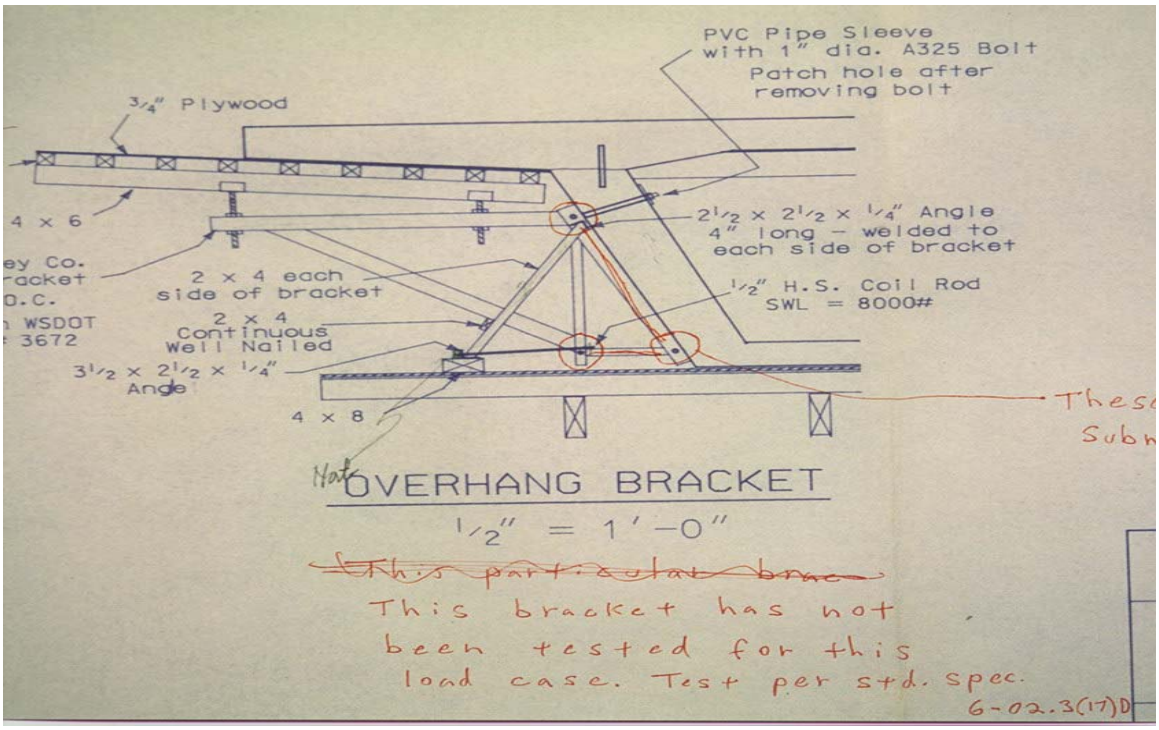
Safety

Forms and falsework approvals

Contractor must submit to HQ, detailed plans for department approval!
Except……forms 8’ or less that don’t support the weight of the concrete, can be approved by the PE.

Form "blow-outs"

Generally form blowouts are caused because the approved drawings were not followed. It is quite common for the contractor to say he will take the risk but, to prevent catastrophic failure and injury, strict compliance with the approved drawing is critical. Remember, an inspector's duty is to ensure contract compliance with plans and specifications. Silence is acceptance. A carpenter is not an engineer and cannot build things in accordance with his knowledge. The contractor must follow the drawings to ensure it is built in accordance with an engineer's approval.



Falsework - Temporary support for the structure
Forms that will bear vertical load
Must be on a solid foundation
Falsework - Scaffolding
Falsework – Mudsill
Falsework - Piling

Part Four

Basic Concrete Placement

Fixed - Form concrete

Is the construction of cast in place concrete! Fixed forms can be used for almost any concrete structure. When fractured finished surfaces are required, be sure the forms are approved through the latest QPL. The height of the form liner shall be equal to or greater than the height of the formed surface. Only elastomeric form liners are allowed to have horizontal splices. Formwork is for the containment of lateral pressure exerted by the concrete placed in them! Falsework is to support the vertical and/or horizontal loads of the formwork, reinforcing steel, concrete, and live loads during construction!

Weather and temperature limits

When rain causes a muddy foundation
When rain causes wash or flow of the mix
When the concrete temperature is below 55F or exceeds 90F
When the air temperature is below 35F an enclosure or other approved cold weather plan must be implemented – W/80% humid

Hot weather placement

When concrete temperature would normally exceed 90^0F
Cool components
Limit load size
Park in shade
Cool and wet all forms and foundations
Approve all methods by the engineer

Cold weather placement

No frost or ice
A pre-approved plan to pour and cure
Heat aggregates <150^0 and / or water
Control temperature and humidity for 7 days or cure time whichever is longer
Add moisture for 6 days
Use 24hr recording thermometer
Special attention to edges and corners

Preparations for concrete

Mix designs - Changes
The contractors mix design shall include a plot of combined gradation on the 0.45 power curve showing that the proposed gradation conforms to section 9-03.1(5). The fine aggregate requirement for class 1 or class 2 gradations is then eliminated. Structural concrete must contain a minimum 564lbs. of cement.
Approved materials and equipment must be used. Thoroughly inspect foundation, forms, reinforcement, dimensions, layout, grade, and any falsework! Insure an adequate supply of mix, adequate labor and equipment and back - up equipment on site.

Delivery of the Mix 6-02.3(5)B

Certificate of compliance

Class of concrete per plans
Delivery 1-1/2hrs. increase if < 75^0F
30 revolutions to remix or add water
250 revolutions for central, 320 for truck mixed
Check temperature, slump, and air content, make cylinders
Wet down all forms and foundations
Test per specifications first and/or second load

Mix placement and consolidation

Place concrete as close to final position as possible
Use appropriate chutes, pumps, or tremies
Do not drop more than 5 feet (use tremie or placement device)
Place in layers < 2-1/2 feet in depth
Place continuous with no interruptions longer than 30 minutes
Use internal vibrators @ a min. 7000 pulses per minute

Proper vibrator operation

Lower through mix to previous layer
Avoid contact with forms and steel
Hold vibrator in place until settlement stops
Remove vertically and slowly (no dragging)
Repeat process with uniform spacing
Complete within 15 minutes after placing

Construction joints

Between separate pours within the structure
Only at locations shown in the plans (unless approved in writing)
When the previous pour is complete
At the correct grade
With keyway, rough surface if shown in the plans
With reinforcing steel protruding to the next pour
Clean, roughen, and wet surface before next pour

Requirements – Keyways 8" long @ 16" centers 4" less than the width of the member. Roughened surface – Serrations ½" to 1" wide spaces, ¼" to ½" deep equally spaced.

Expansion joints

Between structures or at specific intervals
Open joints have removable forms while others have compressible material
Place full length and depth
Finish with an edger
Use approved materials and lubricant only

Slip form concrete

Curb, gutter, and barriers
No forms set in advance
Cross brace steel cages
Use automatic alignment and grade controls
Check the wire (get on your knee's and look at profile)
Control slump and speed of placement
Watch for honeycombing, grout, pulling, and tearing

Finishing - Use steel trowels, straight edge, broom, and clear curing compound or wet cure with white reflective sheeting. Remove curing compound after ten days with pressure washer.

Precast concrete

Inlets and Barrier Stamped
Transported and stored properly
Check dimensions, reinforcing, and cracks
Special lifting devices
Foundations compacted and shaped
Footings have shims or pads
Bearings in place

Approved stamps required

Prestressed Concrete, Walls, Girders, Bridge Steel, Poles, Anchor Bolts, Sign Bridges, Epoxy, Treated Timber, RPM'S, and Pipe >30"

APPROVED
FOR SHIPMENT
WASH. DEPT. TRANSP.
N001234

Part 5

Basic concrete post - placement activities

Finishing unformed surfaces
Curing
Removing forms and false-work
Finishing formed surfaces
Backfilling

Finishing unformed surfaces

Slabs, top of walls, construction joints

Set grade nails, chamfers, or forms
Strike off at the correct grade
Initially grade with wood floats
Metal floats and trowels to smooth and seal
Smooth, broomed, or exposed aggregate
Cure starts immediately

Curing

Concrete must be properly cured to control cracking, shrinkage, and warping. The curing method depends on Class of concrete, location, and type of structure.

Curing For….

Bridge Roadway Slabs (except those using 4000D)
Bridge Approach Slabs
Flat Slab Superstructures
Bridge Sidewalks
Box Culverts
Roofs of Cut and Cover Tunnels
All require curing compound covered by white reflective sheeting or continuous moisture for 10 days.

4000D – Two coats of curing compound, applied immediately after tining, and moisture for 14 days. Apply 1 gallon of compound per 150 square feet. Monitor vibrations in the area.

Retaining Walls – 3 days wet plus time and strength for backfill.

Culvert Sidewalls and floors – continuous moisture for 10 days

Others – Continuous moisture for 3 days. Run-off water is not to enter surface waters.

Curing methods

Curing traffic barrier

Keep forms and blankets wet for 3 days
Remove forms and wet for additional 7 days
Finishing may begin after 3 days, steel/dense forms can be removed after 24 hrs and 1400psi

Slip form barrier

Two coats of clear compound and white sheathing
Remove curing compound by blasting

Removing forms and falsework

Must have engineer's approval!
All must be removed if accessible!
No damage to structure!
Meet time and strength requirements**.**
Traffic and pedestrian barrier...

> Side forms may be removed after 24 hours and 1400 psi if water reducer was used

Review standard specifications 6-02.3(17)N for each component!

Finishing formed surfaces

Reasons for finishing:

To seal the surface
Prevent rust of rebar
Provide uniform pleasing appearance

Finishing concrete - Class 1

Thoroughly wash the surface by abrasive or water blasting
Apply 1:1 mortar (sacking)

Remove excess mortar with carpet or burlap
Fog spray with water after initial set
Continue wet cure for additional two days minimum
Broom Finish on Slip form Barrier

Finishing concrete class 2

Fill all holes and smooth lips and edges
Surfaces covered with fill do not require a finish but need sealed

Column rock pockets

Very difficult to send a body down and get proper consolidation
Column Pour back – this column was accepted and poured back.

Backfilling

Bridge ends - Non-clay material less than 3” in diameter, no frozen or foreign material, placed 14 days and after 90% design strength, compacted to 95% for 100’ and then on a 10:1 to original ground.

Part 6

Introduction to Bridge Foundations

Structure excavation

Classification of structure excavation
Preliminary duties before excavation

Types of excavation situations

Open pit, basic dry, or rock
Shoring and cribbing or extra excavation
Wet foundations
Piling

Foundation features

Basic Concrete Footing - Barrier / Retaining

Spread footings

Abutments and Columns

Pilings and shafts

Walls, Abutments, and Columns

Structure excavation

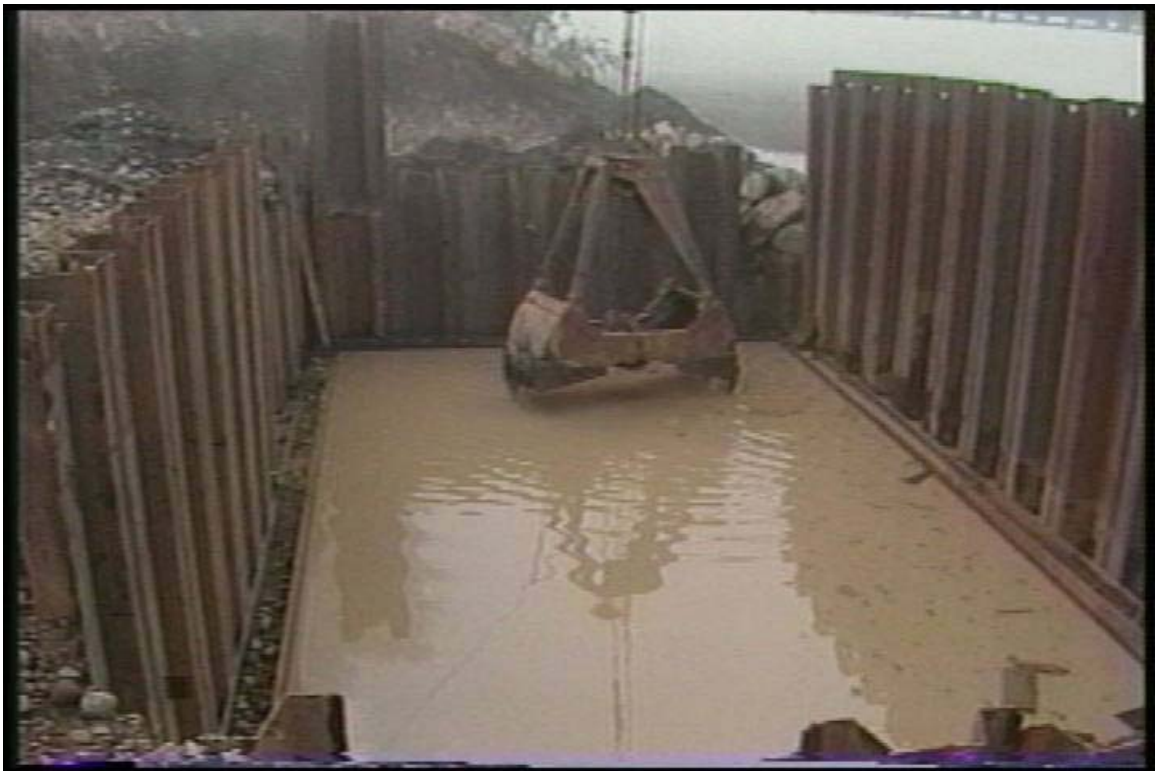
Classification

Class A
Bridge footings, pile caps, seals, wing walls, and retaining walls

Class B
All other excavations - Drainage

Types of excavation situations

Preservation of channels



In or next to rivers or streams
Excavate in cofferdam, caissons, or sheet piling
Never disturb stream bed outside of cofferdam
Backfill after structure is above the level of original stream bed
Remove any excavation material left in the stream
Place rip rap on the exterior of sheet piles

Preliminary duties

To have stakes set;

Ask the contractor what will work!
Cross section to ensure original ground for payment
Check plans, boring logs, and special provisions
Ensure location and effects of surroundings
Visual inspection and reference to stakes
Read soil logs
Check water table and look for unsuitable material
Verify approved shoring / cribbing / materials

Open pit “glory hole” excavation

Cross section original ground
Can not be in or near water
Material must be stable for safety
Must control ground water

Can not disturb or damage any existing pavement or adjacent facilities

Basic "dry" excavation

Cross section original ground
Stake center of footing with RP's
Use approved shoring and cribbing plans
Examine material for future use
Check dimensions of excavation
Check foundation - Gravel Backfill Class A
If using gravel backfill - 95% compaction
Notify materials lab before pouring

Foundations on rock

Footing must be keyed into Rock 1 foot minimum
Must be firm, solid, and must be:
Level
Stepped or
Serrated

Shoring or extra excavation class A

Shoring plan must be approved
Excavation is deeper than 4’
Next to a structure or roadway
Must provide adequate space for workers and forms
Is paid lump sum 0.3m (1’) outside footing or seal
Trench boxes are not allowed

Soldier Pile Tieback Wall

Placing Piles – temporary casing installed
Drilling – excavate to proper depth
Pouring – concrete class 4000
Pulling Casing – install H-pile and pull casing for template
Inspecting – check pile length, embedment and test concrete
Placing Piles – check elevation
Complete Pouring – CDF is used where lagging will be installed
Remove temporary casing
Install Lagging – excavate 4’ and install from top down
Install, grout and Stress Strands – call Geotech for instruction
Ram gage used – to verify pressure, micrometer to verify slippage
Wedges on Strand – be sure wedges are secure before pulling strand
Complete Lagging and Backfill – check specials / spec’s for backfill

Soil Nail Wall

Excavate four to six feet
Drill for soil nails and grout them in
Install drain materials and weep holes
Install reinforcing steel for wall
Shotcrete wall
Install anchors for fascia panels if required
Continue back to step one excavating four feet at a time
When complete, install fascia panels

Part 7

Piling

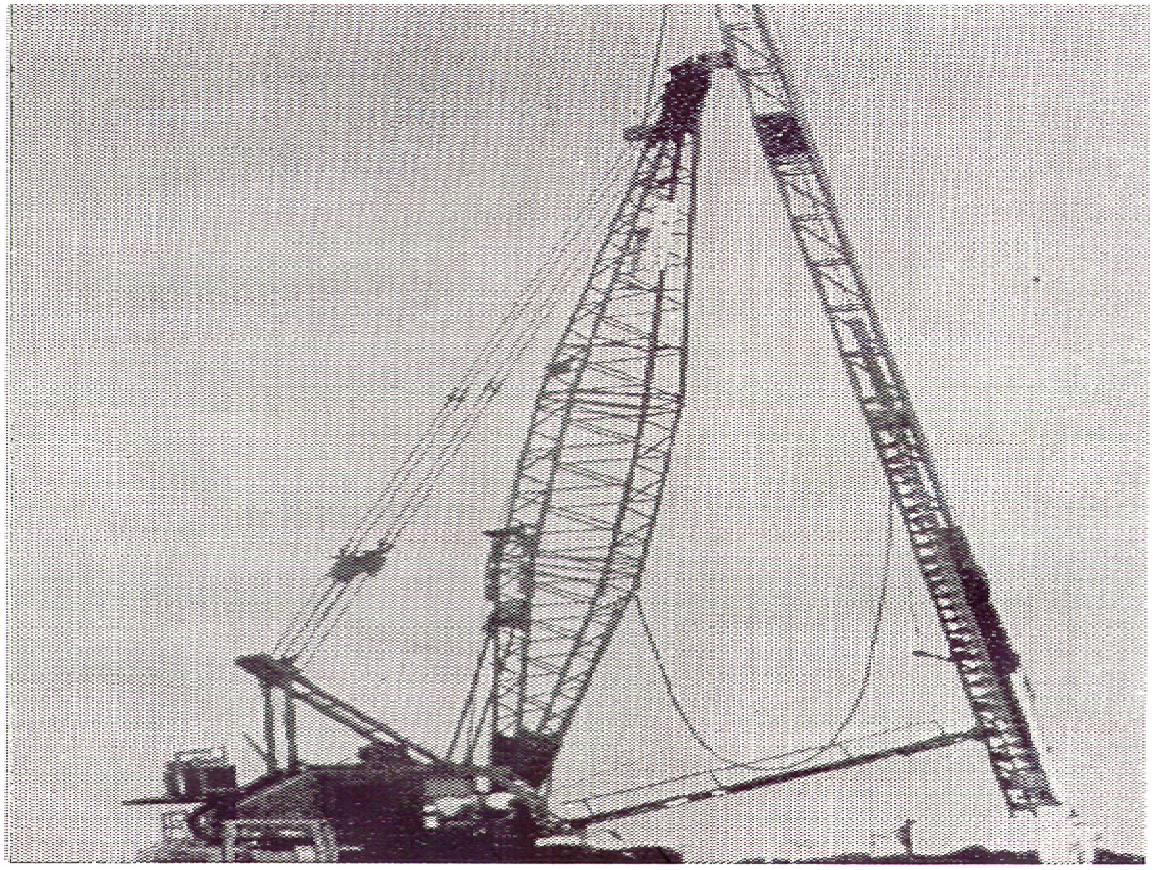
Types of piles

Timber piles
Steel “H” piles
Pre-cast concrete piles
Cast in place concrete piles

Pile driving

Fixed lead

Attached at the top of the crane boom and bottom of the crane
Hydraulics at the bottom allow the lead to be moved for the correct alignment of the pile



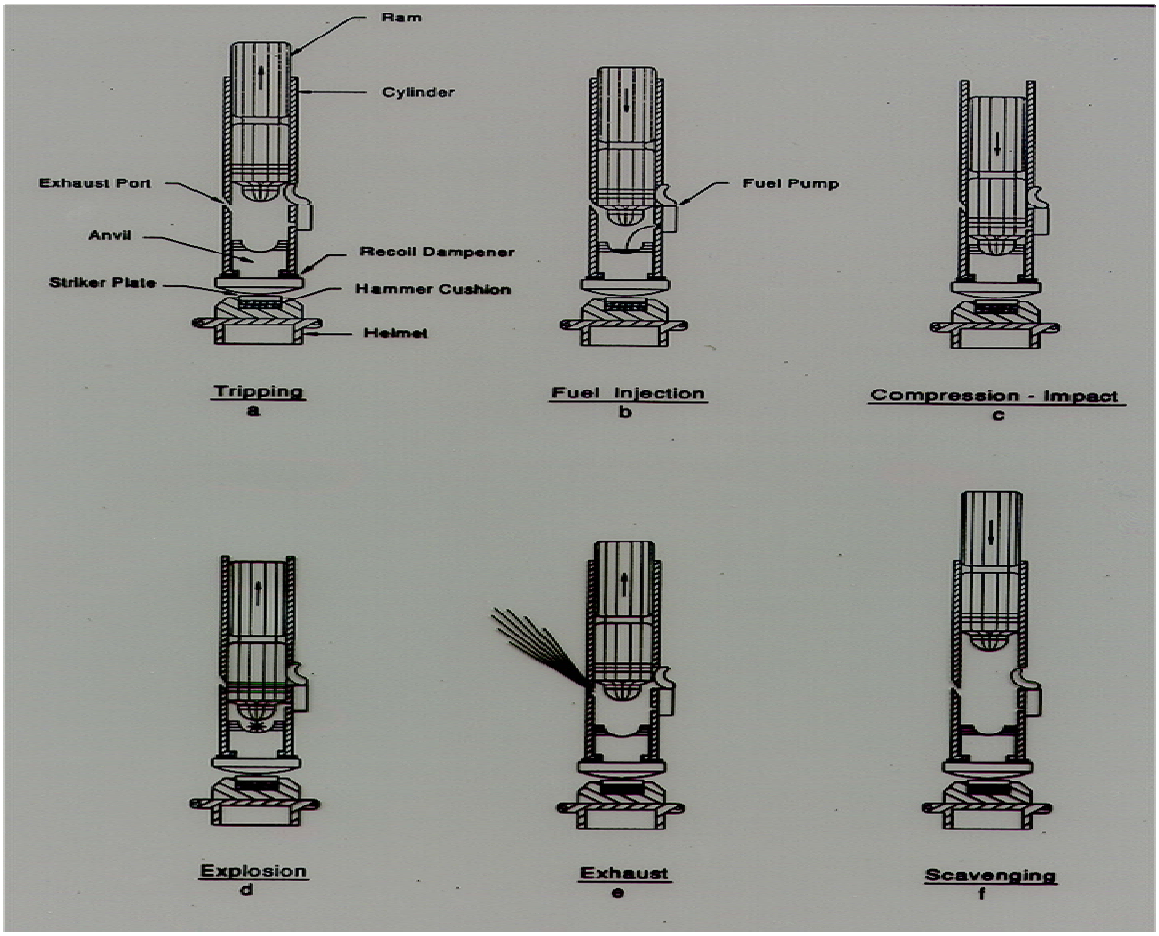
Semi-fixed lead

Is attached only at the top
Requires HQ approval to use and may require PDA (Pile Driving Analyzer)

Swinging Lead

Non-Fixed Lead
Lead swings freely
Requires HQ approval, template probably required with PDA

How Single Acting Diesel Works



Preparations for Pile Driving

Complete excavation or embankment
Check pile layout – ensure it's in the footing
Obtain and review equipment spec's
- Rated capacity
- Hammer or ram weight
- Hammer stroke or fall distance
- Bearing data calculations

Preparations for Inspecting Piles

Verify size and type of all piles

Steel;

No bends, check dimensions, length, diameter, and wall thickness
Proper driving tip per approved plans
Get weld procedure and welder information for splices

Timber piles

Cut below but swell
No unsound knots
Straight within 1% of length
No twists over ¼ turn in 10'
Strapping – at 18" and 24" from butt end, 1' from tip, 15' intervals

Precast concrete

True alignment
Cross sectional dimensions
Any defects from shipping or handling
Observe handling before, during, and after driving

Prior to Driving

Mark each pile at 1' intervals
Check entry alignment
Install test pile when applicable
Monitor driving
Full contact between pile and ram
Monitor and record penetration

Preparations - Pile Quantities

How many piles are required per contract
What are the lengths
- Pile length is unknown until a test pile is driven
- Pile lengths will vary when driving to bearing
- Pile lengths will vary from area to area
- Pile lengths will vary from driving equipment or access
- The contractor is responsible for additional length above cut-off

Test Piles

Are necessary to determine length of need
Are to be the same material as production piles
Timber is to be driven outside of the footing – may be damaged
Steel or concrete is driven inside the footing and used as permanent
Determine bearing values and length for each footing
Always drive to minimum tip first, bearing second
Drive to specified bearing plus 15% and Cut 1' below finished ground

Determining bearing value

Test piles, record each foot driven and values for bearing
Production piles, record values when approaching final bearing
Using manufacturers spread sheet count blows per minute

Delmag Diesel Hammer
Energy per Blow in FT-LBS.

Blows/Min.	Piston Fall	D8-22	D12	D15	D22-23	D30-23
60	4'-0"		11000	13200		
59	4'-2"		11460	13750		
58	4'-4"		11910	14290		
57	4'-6"		12380	14850		
56	4'-8"		12820	15380		
55	4'-10"		13280	15940		
54	5'-0"		13750	16500		33000
53	5'-2"		14210	17050		34100
52	5'-4"	9430	14660	17590	25850	35180
51	5'-6"	9740	15130	18150	26680	36300
50	5'-9"	10180	15810	18680	27890	37950
49	6'-0"	10620	16500	19800	29100	39600
48	6'-3"	11060	17190	20630	30310	41250
47	6'-6"	11500	17880	21450	31530	42900
46	6'10"	12090	18780	22540	33130	45080
45	7'-2"	12690	19710	23650	34760	47300
44	7'-6"	13280	20630	24750	36380	49500
43	7'-10"	13860	21530	25840	37980	51680
42	8'-2"	14460	22500	27100	39610	53900
41	8'-7"	15190		28310	41610	56630
40	9'-0"	15930		29700	43650	59400
39	9'-6"	46820			46085	62700
38	10'-0"	18000			48500	66100
37	10'-6"					

Pile Bearing Calculations (English)

5511 5/13/99 T Powell

1998 Specs.

Given: Hammer wt. 10.14 kips

Hammer: Delmag D46-32 34 to 50blows \ min.

Open Ended (Single acting) Max. stroke 11.1 ft.

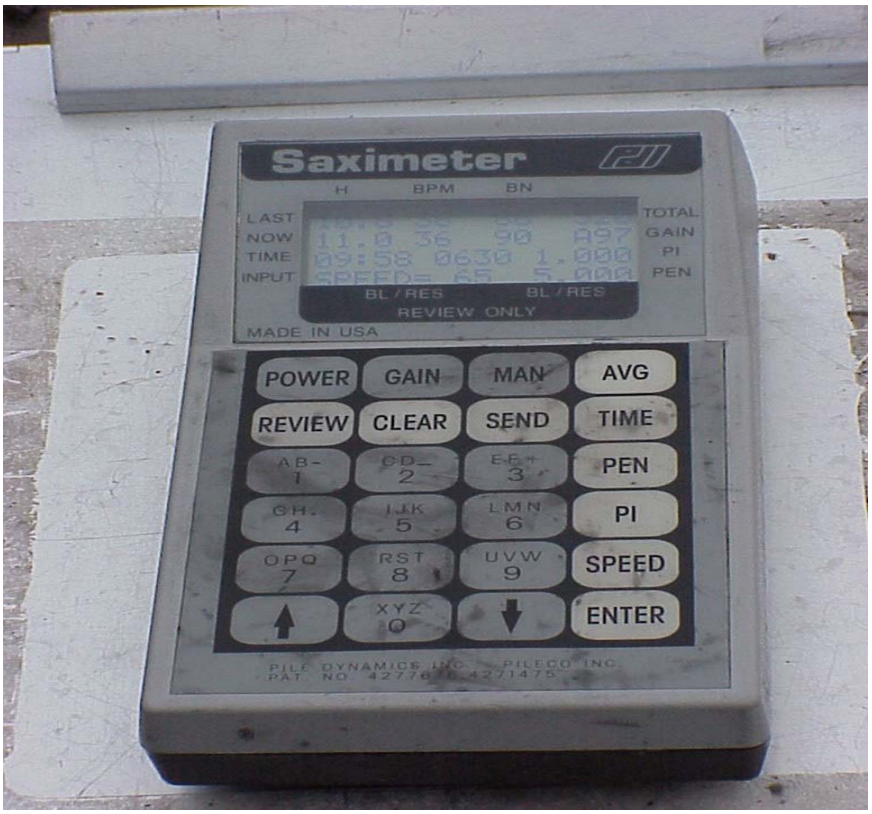
Bearing formula:P=(F x E x Ln(10N))

F= 1.55

Stroke formula: (ft) = (4.01(60/BPM)^2 - 0.3

Stroke(ft.)	5.5	5.7	6.0	6.2	6.5	6.8	7.2	7.5	7.9	8.3	8.7	9.2	9.7	10.2	10.8	11.5	12.2
Blows\min	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34
Blows\in	Blows\ft	Tons of Bearing															
0.83	10	182	190	199	208	217	228	239	250	263	276	291	306	323	341	361	383	406
0.92	11	191	199	208	217	227	238	249	262	274	289	304	320	338	357	378	400	425
1.00	12	198	207	216	226	236	247	259	272	285	300	316	333	351	371	392	416	441
1.08	13	205	214	224	234	244	256	268	281	295	311	327	344	363	384	406	430	457
1.17	14	211	221	231	241	252	264	277	290	304	320	337	355	375	396	419	443	471
1.25	15	217	227	237	248	259	271	284	298	313	329	346	365	385	407	430	456	484
1.33	16	223	233	243	254	266	278	292	306	321	338	355	374	395	417	441	468	496
1.42	17	228	238	249	260	272	285	298	313	328	345	363	383	404	427	452	478	508
1.50	18	233	243	254	266	278	291	305	320	335	353	371	391	413	436	462	489	519
1.58	19	238	248	259	271	283	297	311	326	342	360	379	399	421	445	471	499	529
1.67	20	242	253	264	276	288	302	317	332	349	367	386	406	429	453	479	508	539
1.75	21	246	257	269	281	293	307	322	338	355	373	392	414	436	461	488	517	549
1.83	22	250	261	273	285	298	312	327	343	360	379	399	420	444	468	496	525	557
1.92	23	254	265	277	290	303	317	332	349	366	385	405	427	450	475	503	533	566
2.00	24	258	269	281	294	307	322	337	354	371	390	411	433	457	482	511	541	574
2.08	25	261	273	285	298	311	326	342	359	376	396	416	439	463	489	517	548	582

For single acting diesel go to;
http://wsdot.wa.gov/biz/construction/applications.cfm



Saximeter can be used to count blows, it works off vibrations. The contractor may supply you with one if you ask.

Pile Driving

P= F x E x Ln(10N)

P = Ultimate bearing capacity, in tons
F = 1.65 for air/steam hammers
= 1.55 for open ended diesel hammers
= 1.2 for closed ended diesel hammers
= 1.9 for hydraulic hammers
= 0.6 for drop hammers
E = developed energy, equal to W times H[1], in ft-kips
W = weight of ram, in kips
H = vertical drop of hammer or stroke of ram, in feet
N = average penetration resistance in blows per inch for the last 4 inches of driving
Ln = the natural logarithm, in base "e"

Pile splices and extensions

For steel piles and shells
Minimum of 10' between splices
Welded splice ONLY - approval required

Timber - Splices NOT ALLOWED

Pre-cast concrete - Splice after achieving bearing

Pile cut off
To specified elevations
Parallel to bottom of footing
Treated timber (timber encased)
Two coats of approved preservative usually a heavy coat of roofing asphalt

Completing cast in place piles

Inspect interior of shell after driving

No kinks, dents, water, or foreign material

Install reinforcing steel

Verify Size, Length, Grade of steel and clearances

Place concrete (Class 4000P)

Place with 5' Rigid Conduit
Top 5 ft. of concrete pour, tip of conduit MUST be in concrete
As a minimum vibrate the top 10' but in all cases vibrate to a point 5 ft. below original ground line (fill situation)
Properly wet cure

Drilled shafts

Design

Shafts may very in size and depth, they may be designed with side friction, end bearing, or both

Preparation

Review; Plans, Specs, Special Provisions and Geo-technical Report
Discuss Ground Conditions with Geo-techs

Drilled shafts submittals

Contractors Experience
Completed 3 separate projects within the last 5 years
On site Supervisor has minimum of 2 years experience

Installation Plan

Ensure contractor is approved through HQ
Notify bridge construction office, after approval and before installation, so a class can be given for monitoring installation.
Must contain;

> Equipment to be used, shaft installation sequence, excavation methods, how to deal with obstructions, reinforcing steel placement, supports, concrete placement methods, and how to prevent caving

Common equipment used

Clean out bucket

Auger

Temporary casing used to prevent caving

Steel placement and internal supports

Concrete placement

Grabber used for obstructions

Oscillator used to drive temporary casing through obstructions

Preconstruction meeting required for shafts

Check the special provisions for meeting requirements, they should include attendee's such as;

Project office
Contractor
Specialty contractors
HQ bridge construction office

Drilling in the wet or dry for shafts

When drilling in the wet, all wet shafts will have to be tested with the cross sonic log tester (CSL). Steel tubes are attached to the interior of the reinforcing cage and capped. During the concrete placement the tubes will be filled with water to prevent the heat of hydration from deforming them. HQ fabrication inspection will be notified to test these shafts within the specified time. After satisfactory results are achieved, the tubes will be grouted back and any voids around the shaft will be grouted.

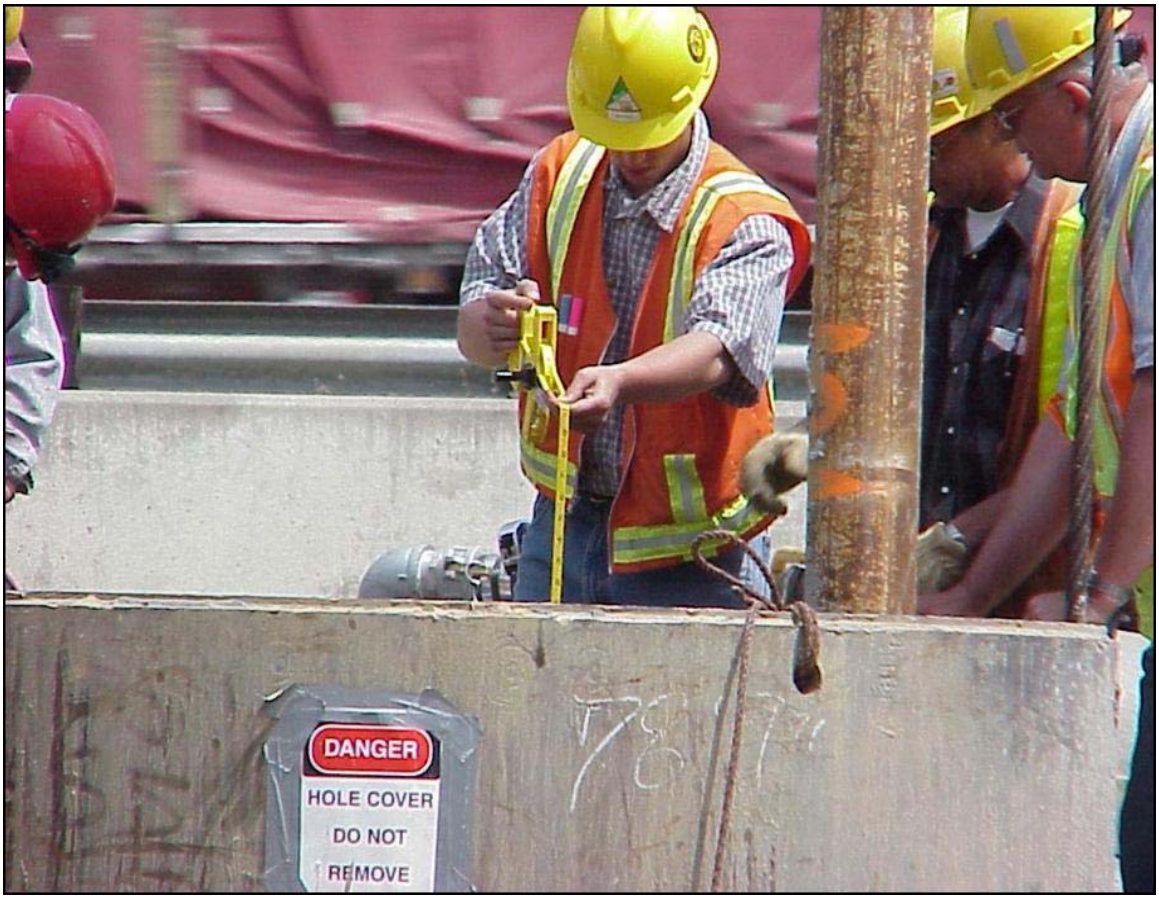
Excavation

Check Location and Alignment
Is it within Footing Area?
Once Started – Continuous

If stopped Temporary Casing or shaft may have to be backfilled. Make note of the last elevation achieved and resound when excavation begins. If there is a discrepancy, notify the bridge construction office. During excavation, continuous monitoring needs to be done to verify the shaft meets the plan dimensions, ie…if they removed a couple auger loads of material and the elevation rose or didn't change a cave-in has probably occurred.

Additionally, continuous monitoring is required to document and compensate the contractor for obstructions. The obstructions encountered will be paid by force account if production is impeded.

NO open holes overnight
Cover excavated area.



Concreting

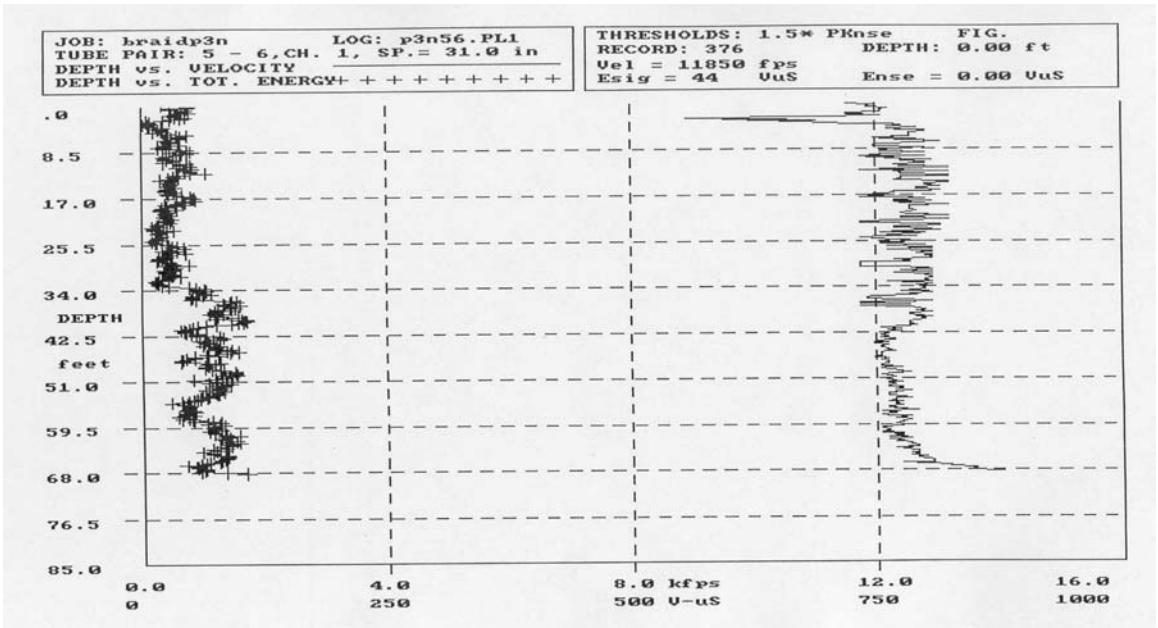
During concrete placement, continuously check the elevation of the concrete. If the elevation doesn't come up to the anticipated elevation for the amount of mix being placed, make notes as to the elevations and volume of concrete used. Notify the bridge construction office.
When in wet method of construction, sand content test must be performed before placing the concrete. This tells us how much silt is in the water and may settle into the concrete or to the bottom of the shaft.

If water is in the shaft, approved slurry may be used to prevent caving and collect silts. The slurry helps the material bind together; therefore helping keep the side walls from collapsing and helps the silts to stick to the auger as the material is removed.

When pouring concrete under water, the conduit used to place concrete must remain in the concrete and be at least five feet below the concrete surface.

The temporary casing is removed while the concrete is being placed. The concrete must remain five feet above the bottom of the casing while it is being removed to prevent any chance of a cave-in.

Don’t forget to get the shaft tested!



Part 8

Wet Foundations

Basic cofferdam requirements

A watertight enclosure to allow dewatering
Shall be used in water or when ground water affects the foundation
Must extend well below the excavation
Allows construction in the dry
Be of adequate size to build a footing

Caisson

Caissons can be used in swift, deep waters. They are partially prefabricated and floated to the site. Then they add to the top and it sinks as they go. When it touches down on the bottom of the waterway, the bottom of the caisson is removed and excavation commences from the top to seat it in the soil.

Preparations

Provide six sets of drawings
Review for field conditions
Structures, Utilities, Water Elevations
Sequence, Materials, Connections, Depths
Boring Logs – what's down below
Piling lay out
Clearance for forms, pumps, workers
Check for required permits
Engineers approval before starting
Driving sheet piles
Ring or guide used as template

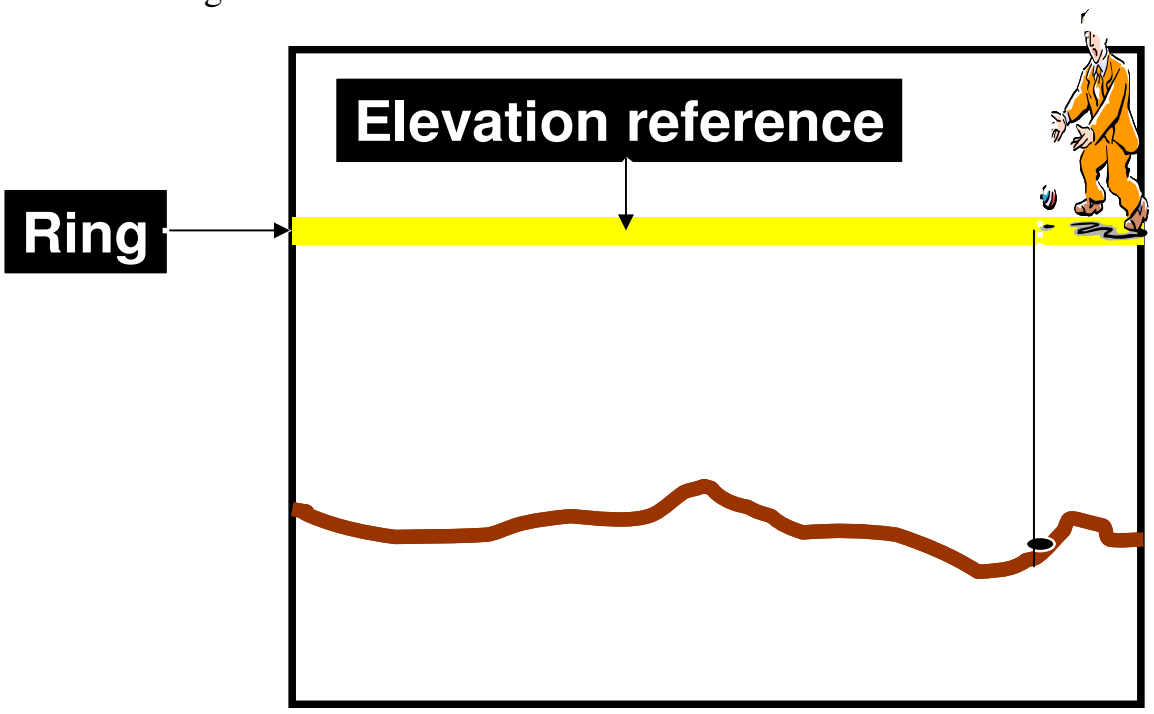
Driving sheet piles

Common-deep arch interlocking pile
Ring or guide used as template

Start driving at one corner, must be plumb, drive each pile +/- 3 feet at a time to ensure they don't bind and to close (the last one fits)

Wet excavation

Generally the same requirements apply as for dry excavation except soundings will be used for elevation checks instead of blue tops
Adequate bracing is needed to prevent collapse during excavation
Unsuitable material replaced with gravel
Standard Specification 9-03.1requires 2 - 6” lifts
Use a clam shovel for excavation
Take soundings



Driving foundation piles

Template often used
Check for proper location
Check for proper elevation
Check type of equipment
Drive test pile when applicable
Check pile lengths
Monitor driving operation
Retake soundings

Placing concrete seal

To provide safety and for dewatering

Minimum thickness 18”
Additional thickness will be based on water pressure and vent elevation
Piles / shafts extend through seal
Concrete Class 4000W with 7” slump is used
Placed continuously with submerged 10” tremie and hopper or concrete pump.
Suitable plug needed for tremie
The water inside and outside of the cofferdam shall remain at the same elevation during concrete placement.
Take soundings

Dewatering Cofferdams

Provide vents at HMW
Cure concrete 3 days for gravity seal
10 days with piles or shafts
Could be longer based on permits
Pump out water
Seal leaking joints
Clean the seal before placing footing

Completing construction

Complete the footing and pier in the dry
Backfill to original condition
Flood the cofferdam
Place rip rap on exterior
Remove sheet piles a minimum of 2’ below original bed

Part Nine

Prefabricated Girders

Prestressed concrete girder

The deck thickness is constant while the depth of concrete directly over the girder varies to adjust the profile grade and make for a smooth ride. The camber of these girders must be checked prior to setting deck grade. This is to ensure the camber does not interfere with the deck thickness or reinforcing steel.

Prestressed concrete T-girder (Deck bulb-T)

The top of this girder can be the finished deck. In this case the top of the girder should meet the tolerances of a finished bridge deck.

Structural steel

Again the deck thickness is constant while the depth of concrete directly over the girder varies to adjust the profile grade and make for a smooth ride. With steel girders, the profile should be taken after the steel has been bolted.

Prestressed concrete tub girder

These girders are generally prestressed for shipping and erection and then post tensioned once in place.

Key aspects

Bearing Points - rest on piers or abutments
Camber - fabricated curvature of a girder before it is loaded

Deflection – Settlement under load

Diaphragms – Keep the girders stable from horizontal loads. The cross bracing may be released upon completion of the diaphragms.

Segmental Bridge – Segments for this type of structure can be prefabricated or cast in place. All the ones in Washington have been cast in place so far.

Bearing points – rest on piers or abutments with one end generally rigid and the other an expansion end.

What is crush?

The take up of slack in the falsework joints when dead load is applied. Crush must be accounted for on the shop drawing and added to the rail of the deck finishing machine to get the proper profile. It also needs to be checked before and after each concrete pour to verify it is, has, or will come out as shown in the drawings. When different materials are used in the falsework, and the details differ from what is shown in the shop drawings, it can be of extreme concern. If one leg settles more than another, the falsework could come crashing down.

Prestressed concrete

Basic girder construction

Check caps for elevation and alignment
Bearings per plan and grout pads at or above 4000psi
Girder stops - correct dimensions and have the plan clearance
Caps must attain 80% design strength prior to placing girders
Girder stops should be placed after girders are erected

Girder transport and delivery

Must be plumb!
Supported 3'-8' from end check spec for requirements based on length
"Approved for Shipment" stamp or tag must accompany girders
Check dimensions, length, camber, rebar, inserts, through holes, loops, and block outs upon arrival

Erecting girders

Stay out of the way until set!
Properly handled (per erection plan)
Proper equipment (cranes and straps)
Properly aligned and seat
Ensure that the elastomeric bearing pads are placed inside the girder recess area and are not pinched or edge loaded
Check for plumbness of web
Install Rebar before setting last girder
Bracing after erection (remain until diaphragms)

Constructing diaphragms

Diaphragms are to provide girder stability during deck placement
Check Reinforcing steel for;
Threaded inserts to the inside
Through holes on interior girders
Open joints between girders and girder stops
Intermediate diaphragms poured first
End diaphragms poured last

Rigid frame construction

Basic requirements

Approved falsework drawings
Foundation, piles or mudsills
Rigid and well secured supports
Wedges in pairs, screws, jacks used proper
Proper size and spacing of members
Cross bracing required upon erection
Crossbeam falsework can be removed after 5 days and 80% strength, before deck is poured.

Deck Bulb-T girders

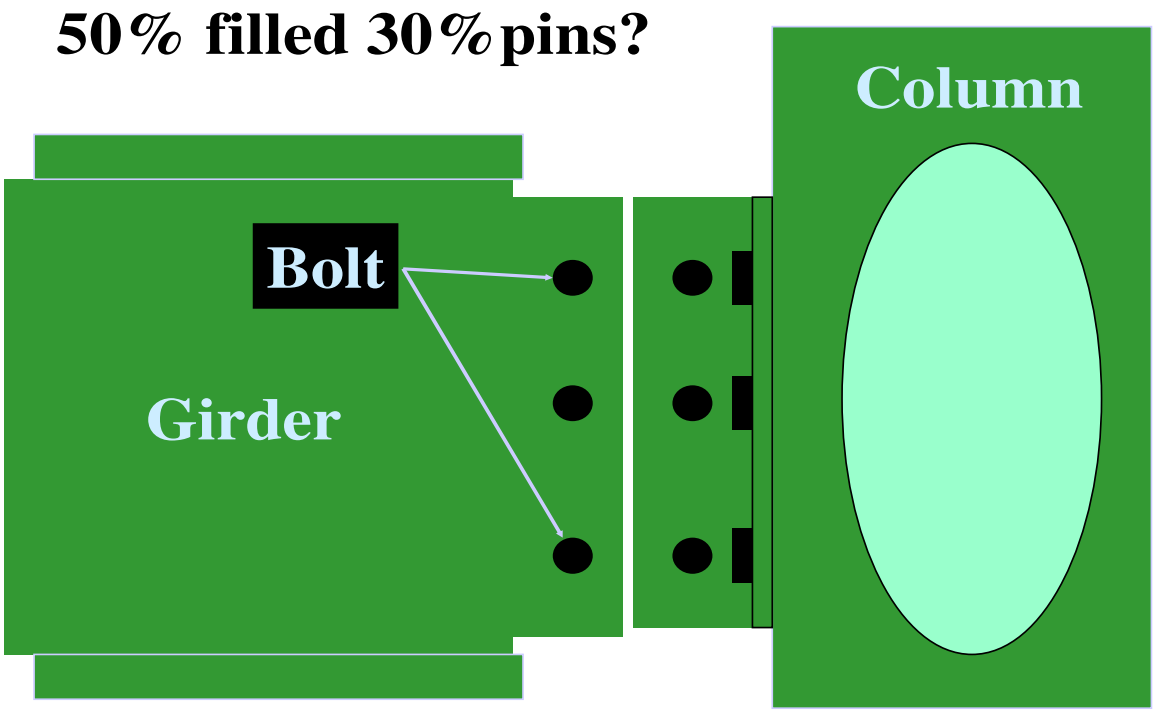
Grout pads can be parallel to roadway!
Check top as finished deck!
Tolerance 1/4" in 10'
Webs perpendicular to road
Equalize camber and profile (jacks/weights)
Diaphragms cast from temp. through holes
Weld joint connections - grout - remove jacks after grout attains 4000psi

Steel girders

Check bearings to match plans!
Proper shims and grout holes for anchors
Bearings true milled
Upper plates ready to receive girders
Caps at 80% design strength
Check studs for proper weld

Transport, delivery, and inspection

Damage corrected before erection
All dimensions at 65^0
Contact surfaces free from grease / paint
Normally - 50% holes filled with 30% pins
Cantilever - 75% holes and 50% pinned



Bolting inspection

Use high strength bolts, nuts, and washers
Tighten systematically from center out
Turn of the nut method and calibrated torque wrench 6-03.3(33)
Direct tension indicators under fixed end only
Contractor checks and tightens
Ten percent or two minimum checked
Clean contact surfaces

Heads on outside and under side, washers on head and nut side!

Additional beam types

Bulb Tee
Rectangular with circular voids
Rib Deck
Box Section
Single Tee
Double Tee

Part 10

Cast in Place Girders

Types of cast in place superstructures

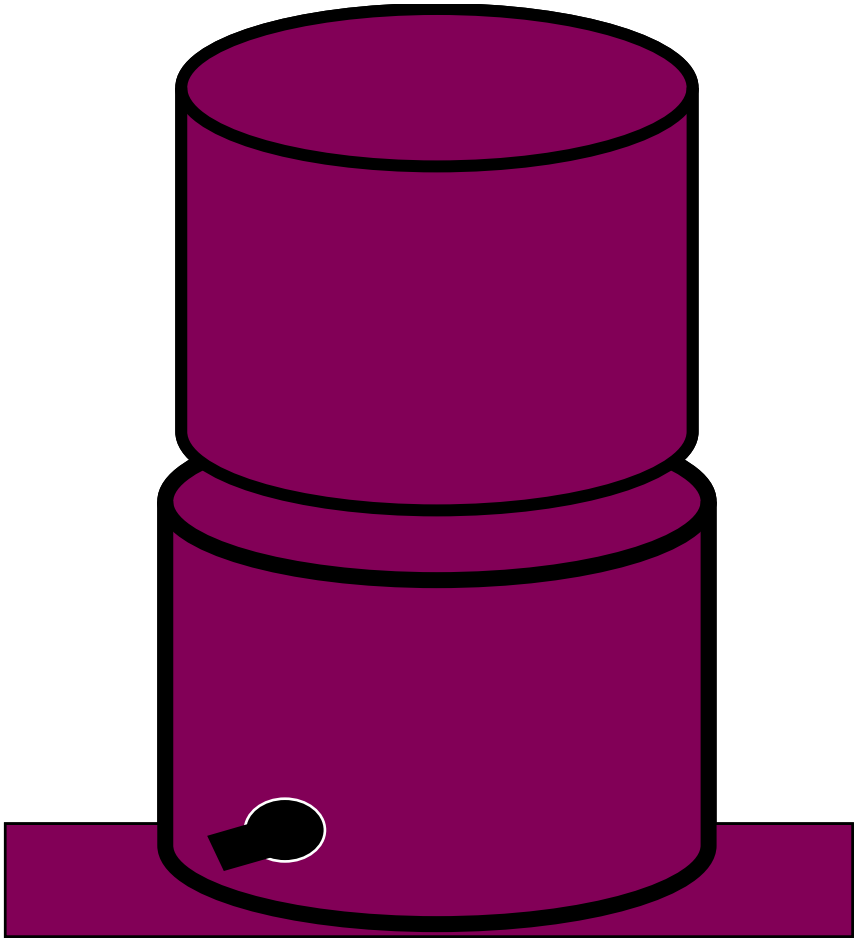
Flat slab
T - beam
Box girder - - most common

Falsework

Per Approved Drawings
Piling is usually required w/permanent piles
Space and drive per approved plans and spec's
False Piles (Bearing per 6-05.3(12)
If load tested, must be twice the design load
Mudsills, twice design load, ¼" max settlement
On undisturbed or 95% compacted, dry soil, grout
Five days required for approval of off site material
Must have erosion control to prevent undermining
Shown total settlement, 1" max for crush & sill

Support systems include;

Vertical Posts and Diagonal Braces
Secure Fasteners
Show location, type, size and connections
Grade Adjusting Devices
Wood Wedges one pair allowed per leg, fastened with one block
Screws or Jacks – Vertical with uniform bearing, must be used in arches for incremental release
Manufactured Devices
Friction Collars, Brackets, Sand Jacks etc…tested and certified, showing make, model, and capacity



Steel w/concrete plug per 6-02.3(17)A

Bottom plate welded to cylinder and filled with sand, top cylinder sealed and empty, inserted in bottom cylinder. To release, remove plug and empty sand. Used to gently release falsework!

Stringers, beams and joists;

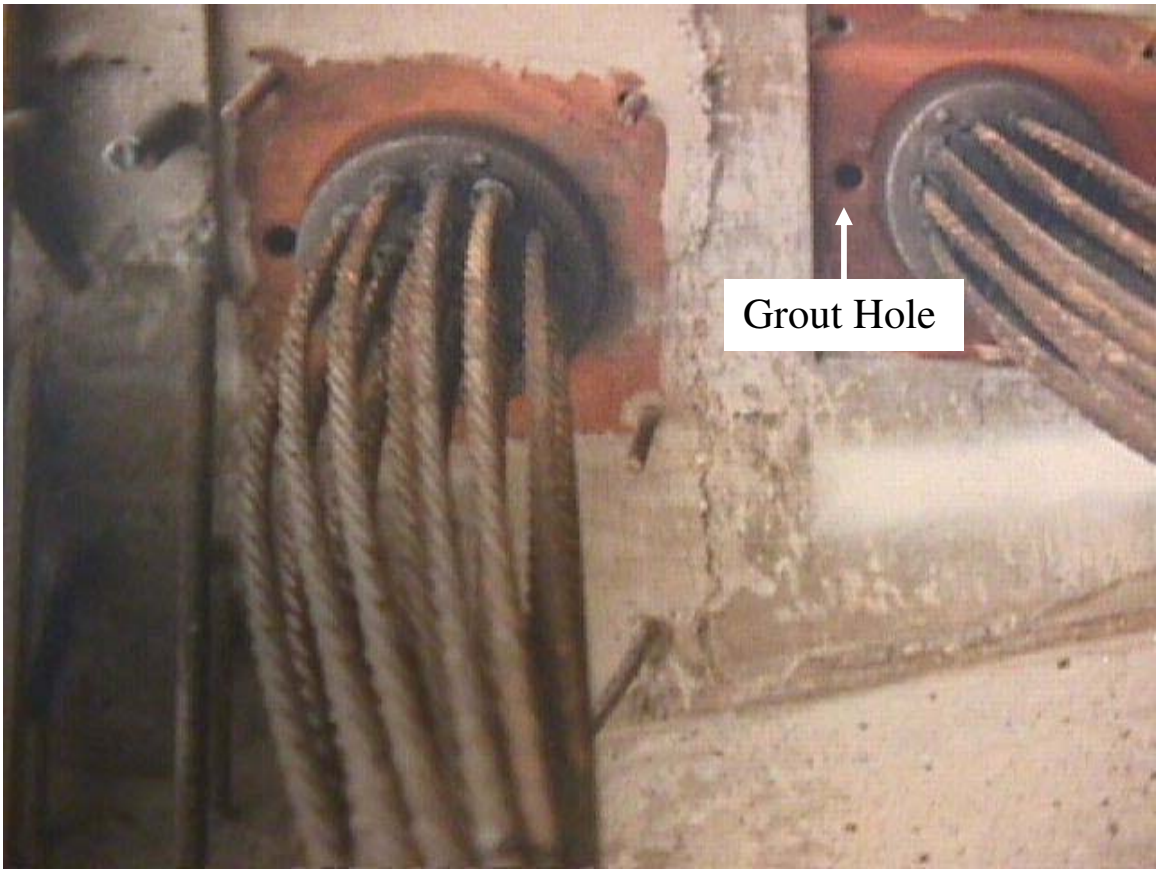
Must be rigid
Like new condition
Correct size and spaces
No deflection over 1/500 of span length
Tell-tales at mid-spans to check for settlement and require re-shoring if more than 3/8” settlement in any one pour.

Bottom slab

Check re-steel and stem layout
Check pier and abutment bearing areas (construction joints, bearings, and open joints) to ensure they're clean and free moving.
Grade B or better plywood forms for exposed surfaces
Check reinforcing steel clearance and supports
Be sure PT drains are installed through the bottom slab and cell drains are installed at low points for each cell.

Box girder stems

Check Side Forms for Correct Batter
Check End Forms for:
Block outs of PT anchors and anchor plates with grout hole on top



90^{o} Angle for P-T bearing plates

Reinforcing steel secured and installed around anchors **6-02.3(26)B**
Check shop drawings for additional steel in the local zone of anchors
Check post tensioning ducts for alignment, type, and size per approved plans & drawings.
PT alignment and transition should have a smooth profile.
Duct joints - mortar tight (duct tape), no kinks, dents, or holes
P-T ducts anchored and secure
Drains at low points (open)
Vents at high points (closed)
Check for conflicts with rebar (PT has precedence)
P-T duct ends covered (a rag in the hole and taped will suffice)
All reinforcing steel per plans

Check interior forms for:

Rebar clearances, layout, spreaders, and supports
Form ties to avoid P-T ducts
Drains, Block outs, bracket embedment for deck Falsework

Box Girder Stems

Check internal clearance of P-T ducts
Interior of forms CLEAN

Concrete placement:

Planned pour rate (check shop drawings)
Avoid cold joints (30 minutes to add new concrete to old)
Extra care around P-T ducts (good concrete vibration)

Deck Construction

Preparations

Pre pour meeting discussed in part 11
Ensure grout tubes and vents are in place
Check for voids / honeycombs around ducts (extra vibration)
Watch the vibration of concrete closely, during the pour
May want to pressure test ducts for leaks

Post tensioning

Submit strand sample early
Install PT – strands and audit placement
Check strand condition and size
Check quantity installed from each reel (count them)
Install anchors and wedges (use a pipe over each strand to pound them in)
Insure concrete > 4000psi (check plans and spec's as this may not apply)
Remove side forms from girders
Check cert of load monitoring equipment, certified within 180 days, gauges and jack are a combination **6-02.3(26)G**
Drain tubes open vents closed

Tensioning operation

Per approved and specified sequence
Avoid ends for safety
Pull to 20% of load & mark and measure strands on both ends
Pull to specified load & measure strands
Reduce pressure to 20% and verify seating loss
Document loads, elongation and seating loss
Cut tendons 1" from anchor (No torch) if acceptable (93 to 107% elongation)
A lift-off is required if the elongation is out of tolerance!

Preparations for grouting

Approved materials (corrosion inhibitor **SS 6-02.3(26)F)**
Clean ducts with oil free compressed air
Install caps and valves (bleed hole on top)
Provide standby flushing equipment
Drains closed and vents open

Grouting Operations

Calibrate water in grout mixer
Check grout Efflux time at both ends 11 to 20 seconds
Pressure feed from low end
Waste at each exit until uniform flow
Close exit valve
Bleed each vent at high points
Close exit then inlet (communication required with pump operator)
Must maintain pressure between 100 and 250 psig for 10 seconds (50 to 75psi for transverse tendons)
All caps, plugs, valves closed in place for at least 24 hours

After post tensioning

Pour back post tensioning block-outs
Remove falsework after post tensioning a minimum of 48 hours after grouting
Complete backfill
Construct barrier, railing, curbs etc….

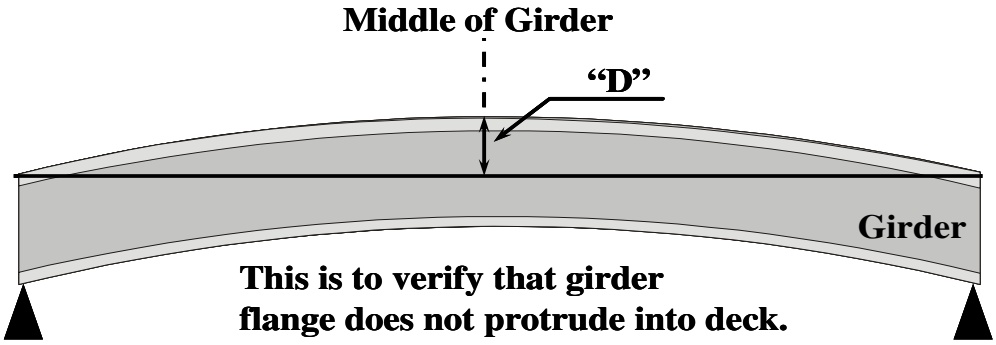
Part 11

Bridge Deck Construction

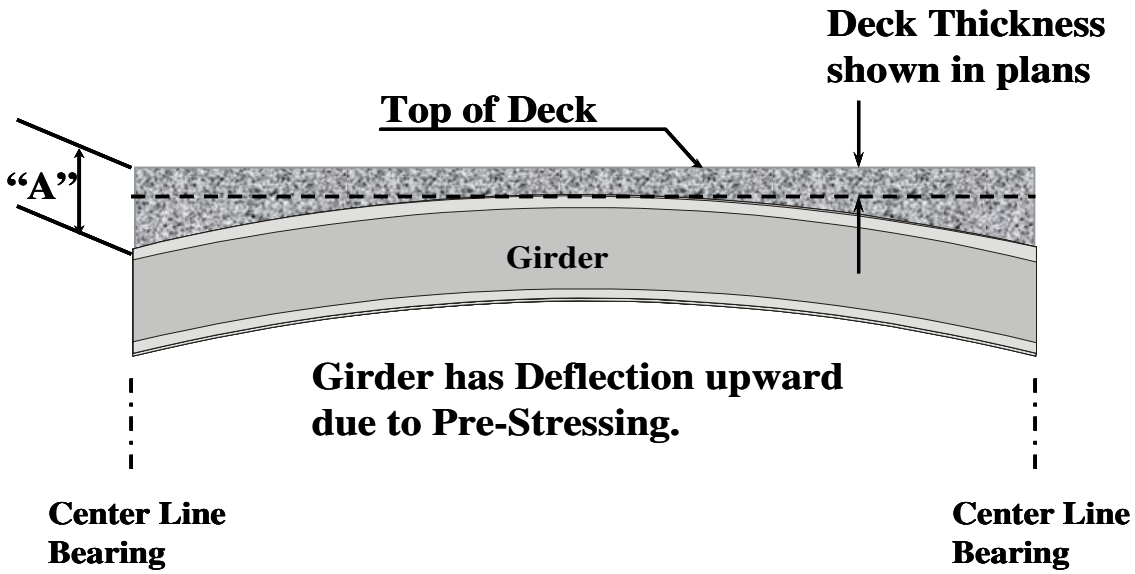
Establishing grades

Checking for Excessive Girder Deflection
Checking "D"

- **"D" is girder deflection upward usually after 120 days.**
- **"D" is given in the Plans under Girder Schedule.**

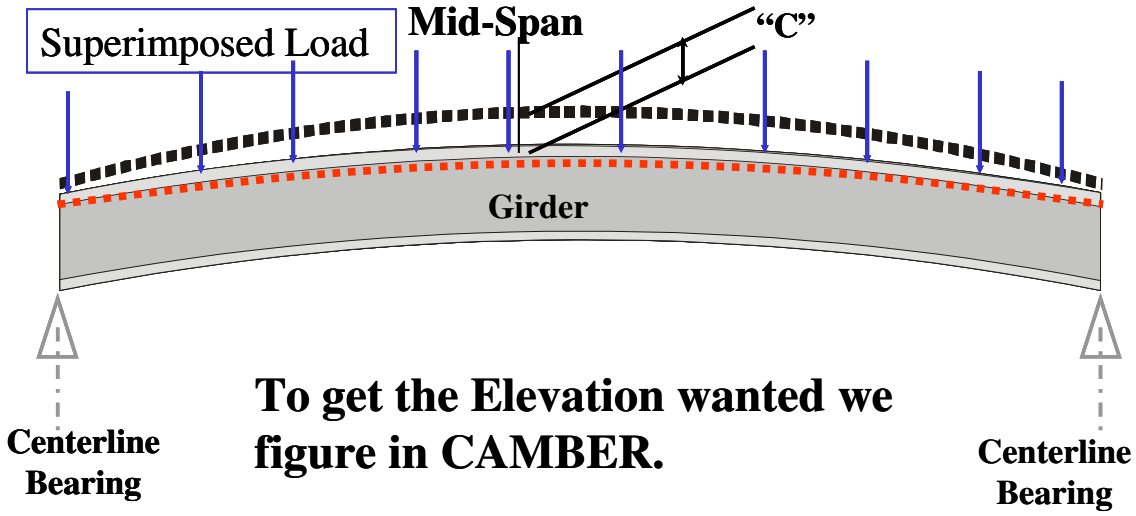


Check Standard Specification 6-02.3(25)K for tolerance of "D"

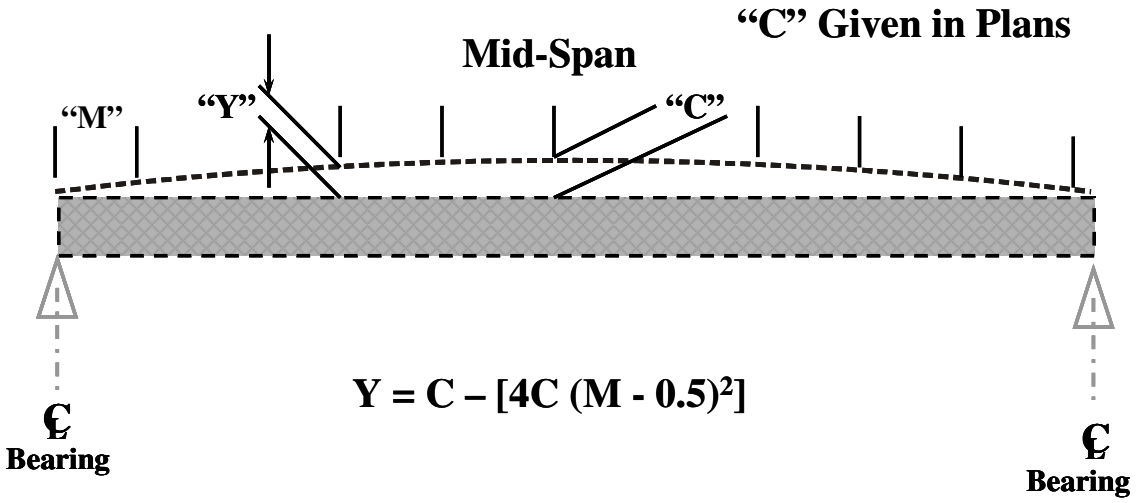


"A" is the thickness of the concrete directly over the girder at specific locations.

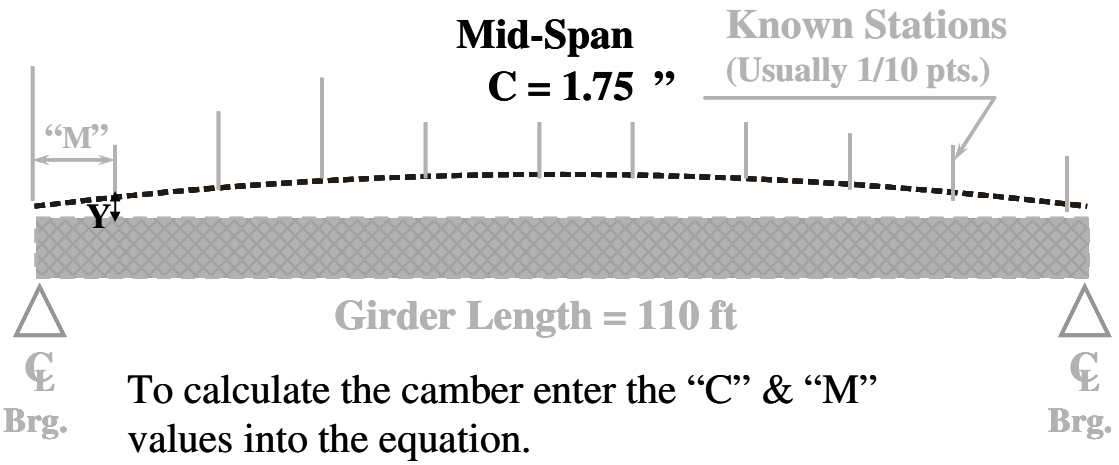
Camber ("C") dimension is the amount of prefabricated curvature deflection upwards, that will deflect downward when loaded with its live and dead loads. This must be added to the deck profile elevations.



Setting Grades Pre-Stress& Cast in Place Girders



"M" is the desired length from on end divided by the girder length between centerlines of bearing (should be 10'). **To calculate camber enter the "C" and the "M" values.**



To calculate the camber enter the “C” & “M” values into the equation.

$Y = C - [4C (M - 0.5)^2]$

$Y = 1.75” - [4(1.75”) (0.09 - 0.5)^2] = .57” = 0.048’$ **Add to known deck elevation**

Camber exercise
“C” = 1”
Girder length (center to center of bearing) **= 102.7**
Calculate “M” and “Y” distances and give the elevation of the deck at that point, profile elevation = 100.21

Establishing Grades

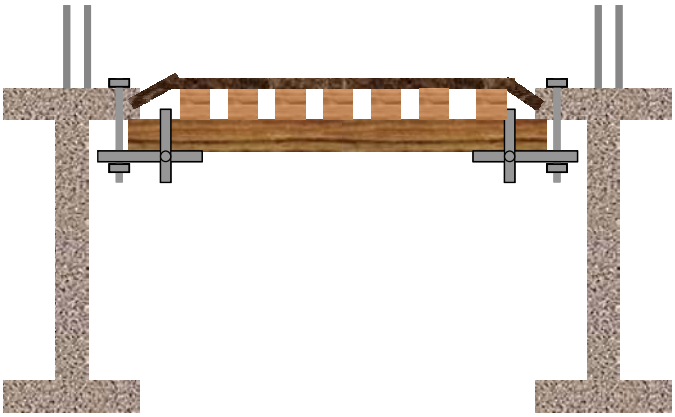
For steel structures;

Profile girders at 10' increments and verify they're where they're supposed to be. Set forms and rail a fixed amount above girder to achieve the proper deck thickness.

Surveying

Mark the profile grade, plus camber, on the stirrup before bending. If pre-bent, mark a fill to profile grade, plus camber, on the girder. Verify the fill is equal to or greater than the "A" dimension shown in the plans. If it's less than the "A" dimension, notify the bridge construction office.

Set deck forms : Profile grade + Camber - Deck thickness

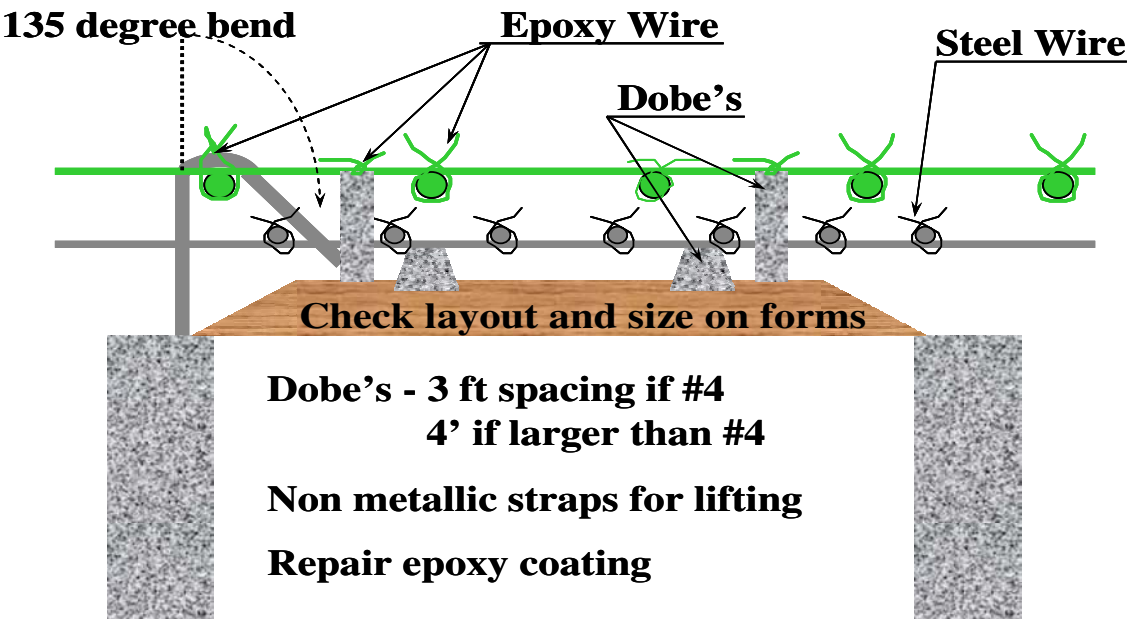


Concrete Girders

Steel and Prestressed girders;

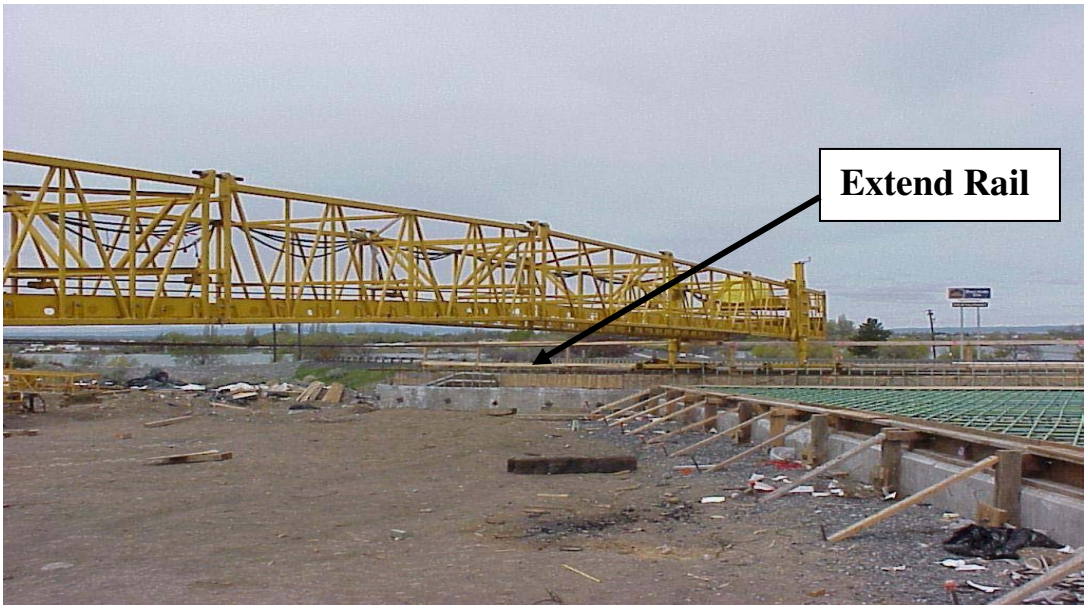
Use approved forming plans
Adjustable hangers
Cantilever angle braces

Re-steel placement

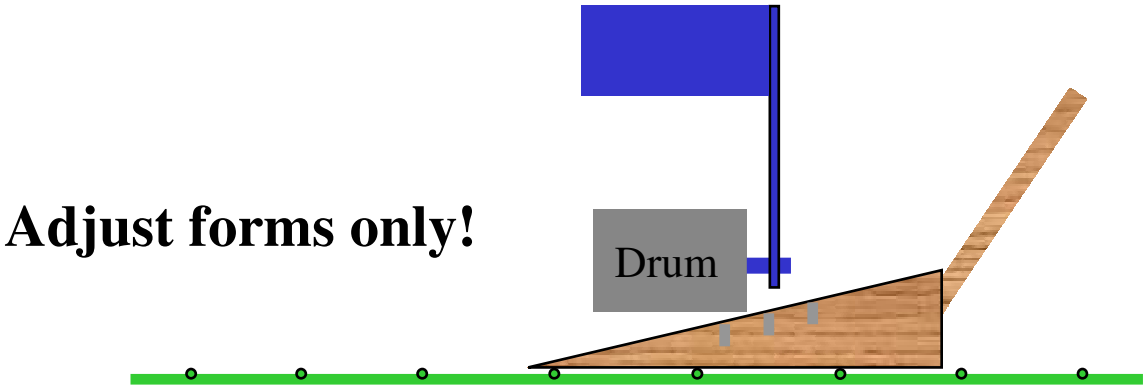


Setting deck finisher

Set rails outside area to be finished
Saddles are adjustable, secure, close and must be removable 2" below the surface, if set within finished deck area.
Rail extends beyond deck area



Adjusting the Stirrups
Checking Drum Clearance



After rail is set and contractor checks forms
Check each bay at various locations for the full length of deck drum to forms and drums to steel

Pre-pour conference

What to discuss;
Equipment
Personnel – Who's in charge?
Timing for trucks (how often, how many, is there a pour rate)
Method of delivery – Bucket? Pump?
Back-up equipment
Weather plan – Who decides and when?
Vibrating, finishing, and curing
Clean-up / wash-outs

Concrete Pre-Placement

Pour sequence?
Stand by equipment?
"Cold Weather Protection" on site?
Curing compound on site & approved?
Water for curing
Finishing machine undisturbed?
Clean-up area established
Curing water contained

Concrete Placement 6-02.3(10)

Steady supply of mix
Sufficient labor force
Vibrating properly in front of finisher
Don't overwork the concrete at the start of the pour

Screeding

Auger uniformly distributes concrete
Slight roll is maintained
Drums make several passes for uniformity
Do random depth checks and record

Finishing

Float to seal the concrete and remove high and low spots
If water is needed, be sure they fog it on, no direct applications
Straight Edging performed by the contractor 1/8" in 10 feet
Tine marks; 1/8" wide x 3/16" deep x ½" spacing, be sure the concrete is not too wet or dry for tines and apply curing compound immediately after tining. If curing compound is not used, get blankets on immediately after tines.

Handwork

Performed around bulkheads, barrier, and sidewalks
All saddle holes filled
Two foot flat surface in front of barrier (not 18")

Curing roadway deck

Roadway deck (Not using 4000D or 4000DLS)
White curing compound and cover with white reflective sheeting or
Continuous wet cure for 10 days
Curing compound applied ASAP!

Roadway deck using 4000D or DLS
Two coats of curing compound followed by 14 day wet cure

Completing the superstructure

Pour-backs / closures complete
Post tensioning complete and grouted 48hrs
Engineer approves removal after proper cure time & strength (time varies depending on type of bridge) Complete backfill, place barrier, approach slabs, and incidentals, check drainage and clean-up

Part 12

Construction / Post construction / Preparation for Construction of Widenings

Preparation

Obtain As-Constructed Drawings
Locate utilities
Locate existing Drainage and check modifications
Check for changes from original construction
Check existing grades, stationing, and dimensions

Construction

Approved demo plans show sequence of removal
Equipment
Size
Type
Impact angle
Approved debris containment plan
Make sure saw cuts are used when required, this allows the full depth necessary to keep the concrete from spalling.
Get familiar with what is to remain and mark it if possible
Verify any splice details and components
Don't make changes without consulting the designer

Post construction

Be sure as-builds are sent off as soon as the structures are complete, don't wait for the entire contract plans to be ready, complete the bridge portions first.